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Safety Standards as Factors in Accident Prevention[1]

by

Cyril Ainsworth, *Safety Engineer*
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General adoption of national safety codes seen as means of reducing the number of industrial accidents

Engineers have helped to give man practically every comfort, luxury, and convenience he enjoys today. Their cooperation has given him railroads, steamships, electricity, automobiles, telephones, telegraphs, radios, machinery for making clothing and preparing food, office buildings, and homes.

These luxuries, comforts, and conveniences are not always entirely beneficial, for they contribute in no small way to the accidental death of 95,000 persons annually in the United States. Of this number 70,000 are killed in homes, on highways, and in public places and the remainder, 25,000, are killed in industry through the manufacture of the products of the engineer's genius.

In addition to the accidental deaths, approximately 3,000,000 persons in industry alone are injured every year so that each is forced to lay off from work for at least a day beyond the shift during which the injury occurred. So few statistics are available that it is impossible to estimate the number of persons injured in public and in home accidents.

From an humanitarian standpoint, accidents result in untold suffering, privation, and poverty to those who are injured and to their families.

Accidents Found Costly

From an economic standpoint, they impose a burden that is costing society millions of dollars annually in charity and in supporting homes for orphans, cripples, and old people. Industrial accidents for but one year represent a loss of 296,000,000 days of work and a net loss of approximately $827,000,000 in wages which must be borne jointly by the workers, their families, and society in general.

To the employers these accidents represent a loss of $187,000,000 in compensation and doctors' bills, in addition to untold sums resulting from decreased production, increased labor turnover, lowered morale, material spoilage, and property damage.

This is an enormous toll in suffering, life, and money to pay for the things that we have come to look upon almost as necessities in life.

It is generally recognized that relief, particularly as far as industry is concerned, is obtainable through two methods: education and the elimination of accident hazards.

Educating our workers in accident prevention is an important and necessary undertaking. Many persons are injured as the result of their own or another's recklessness or thoughtlessness. As an example of thoughtlessness in the *nth* degree, the picture of a man in a tree sawing off the limb on which he is sitting is familiar to everyone. The picture seems very ridiculous but I am familiar with one fatal accident that occurred in exactly that way and with many others which occurred through analogous causes. In addition to this lack of proper thought for one's own safety, there are many employees starting work with absolutely no conception of the dangers surrounding the operation of modern machinery and other hazards which they will be required to face. It is, therefore, necessary to instruct these men in the methods of performing their work safely and to use extensively all the educational media that can be of value.

Education alone will never bring the desired results. Elimination of accident hazards must receive a full share of consideration from all persons interested in the accident prevention movment, but primarily from the engineer.

It is not sufficient to warn the operator of a punch press to keep his hands from under the ram when it is descending. We have not gone far enough when we tell an employee that he must not touch a moving belt with his hands. It is necessary to go much further. The punch press, or its method of operation, must be so redesigned and changed that it will be

[1] Presented before the joint meeting of the Safety Engineers Club of Baltimore and the Baltimore Chapter of the American Society of Mechanical Engineers, November 7, 1930.

impossible for the operator to place his hands under the ram; the moving belt and the pulley over which it travels must be so guarded that it will be impossible for the employee to place his hand in such a position that it will be caught between the belt and pulley or on the belt fastening; and so with all accident hazards.

Safeguards in Original Design

The design, construction, and installation of safeguards and engineering revision are jobs for the engineer. This applies not only to the removal of accident hazards in the establishment in which the engineer is employed but also to the inclusion of proper safeguards in the original design of machines or other products of the establishment. Not only are such safeguards more effective than those that are superimposed on completed equipment, but also the engineer has created a machine which is more saleable because the purchaser realizes that his first cost is his last cost. The design of the most simple guard presents engineering problems. There is the question of the material from which to fabricate the guard; should it be of wood, sheet metal, wire mesh, or expanded metal? What provisions should be made for oiling; and what is the maximum size of openings to be permitted? Fortunately, such basic guarding problems have been incorporated in groups of specifications generally known as safety standards. These standards are the consensus of opinion of what is absolutely necessary for the protection of human life; they are the sum total in experience of hundreds of thousands of accidents; and they contain the fundamental principles of safeguarding which have been so set forth by engineers that no industrial establishment, no matter what its size or the nature of its product, can find a legitimate excuse for not removing all accident hazards within the establishment and in the product which it manufactures.

There are three groups which are principally active in the work of developing safety standards. They are: governmental agencies such as industrial commissions and departments of labor and industry; the National Council on Compensation Insurance, representing the stock, mutual, and state fund casualty insurance interests; and the American Standards Association, which is a federation of forty-seven national technical societies, trade associations, and governmental bodies interested in the development of national engineering and industrial standards including those pertaining to accident prevention. To a limited extent some trade associations, engineering societies, and individual industrial establishments have engaged in this work.

It might be well to examine just what the situation is as a result of the activities of these groups. For many years the National Council for Compensation Insurance and the American Standards Association were independently engaged in the development of safety standards, which resulted in the establishment of two national groups of standards. The insurance interests were always represented on the ASA technical committees and this activity, together with the distressing experiences coming from conflicting inspections in the field between governmental and insurance inspectors, soon brought about the desire that ASA standards and the Insurance Rating Schedule be brought into complete harmony. It was felt that such a policy would tend to produce a single group of national standards which would be used by the insurance interests and which eventually could be used by the governmental agencies as the basis of their standards. The harmonizing of these two groups has been going steadily forward and the work is so nearly completed that it can be said that there is now but one national group of safety standards.

Very little progress has been made, however, in the use of national safety codes by the individual regulatory bodies. A recent study of the regulations of thirteen states showed, in the case of such a simple and fundamental problem as guarding gears, that practically no two states had the same requirements, either as to the type of guard to be provided or as to specific conditions under which gears need to be guarded. A complete study of all existing state standards has never been made because of the size of the task, but if this confusion exists in connection with the removal of such a well-known accident hazard as a revolving gear it is safe to assume that the same condition exists through all the standards.

Confusion Perpetuates Hazards

Such a situation is bound to have a retarding effect on the accident prevention movement. It is not likely that all the different methods specified for removing a particular accident hazard would be effective, which means that despite efforts being made to remove thousands of accident hazards these hazards will continue to exist. Improper advice is being given to engineers as to correct methods of designing machines and equipment, and machinery is being sold throughout the country that will continue to be a source of danger to the employees who operate it.

Let us examine a case in point in order to obtain a more definite picture of this situation. The safety standards covering the guarding of mechanical power transmission apparatus were

among the first to be developed. Every safety engineer has assumed that one of his first duties consisted in guarding belts, pulleys, set screws, shafting, and so forth. The accident hazards which this apparatus presents have received more consideration by safety engineers than any other type of hazard that could be mentioned. A national standard has been prepared by a committee organized under the sponsorship of the American Society of Mechanical Engineers and in accordance with the procedure of the American Standards Association. On the committee were representatives of governmental agencies, insurance interests, manufacturers of equipment, users of equipment, employers, and consulting engineers. The standard was adopted in 1923 and revised in 1927. In order to determine the extent to which this standard was being used in connection with the manufacture of machine tools and other equipment, a questionnaire was sent to a large group of manufacturers of equipment and from the replies the following information has been tabulated:

Number of firms reporting a safety practice in the protection of their product	24
Number of these based on ASA codes	9
Number of firms basing their safety practice on other standards, as follows:	
(*a*) "Experience," "judgment," or "common sense"	7
(*b*) Own code	6
(*c*) State codes (Mich., N. J., N. Y., Ohio, Pa.)	6
(*d*) "Cover all moving parts"—standard used not given	4
(*e*) To meet purchaser's requirements	2
(*f*) Own standards and ASA code	1
(*g*) Own experience and state and city codes	1
(*h*) "Rule of thumb"	1
(*i*) Own experience and to meet purchaser's requirements	1
(*j*) "No exact specifications"	1
(*k*) Not stated	1

The picture speaks for itself.

In terms of the amount of accident prevention work being done under such conditions let us look at the picture from another angle. The Pennsylvania Department of Labor and Industry recently published the results of a study made to determine what sized plant could be considered the most hazardous from an accident frequency viewpoint. The study was confined to manufacturing establishments reporting one or more lost-time accidents during the year 1929. The group of plants which employed anywhere from one to two hundred employees, and comprising 85 per cent of the total number of plants reporting accidents, had an exposure of only 17 per cent of the total number of employees and yet they were responsible for 42 per cent of the fatal accidents and 44 per cent of the non-fatal accidents occurring in the establishments used in the study. This size plant is visited very infrequently by the state inspector because lack of sufficient appropriation to employ a large staff of trained men makes it impossible for inspections to be made more frequently than once a year. Under these conditions, it is safe to assume that a large proportion of the accidents in this class of establishment is due to mechanical causes and this can be traced directly to the conditions outlined in the study of the answers to the questionnaire sent to the machine tool builders.

How can plants of this type be expected to take much of an interest in accident prevention when the machines they purchase, on the supposition that the operators will be protected from avoidable accident hazards, are found to be inadequately protected because the guards designed by engineers were constructed according to "rule of thumb?" Surely every effort possible should be made to insure that machinery sold to a group of establishments responsible for such a large proportion of the lost-time accidents reported to a single governmental agency should be so guarded at the point of manufacture that when placed in operation the machines will produce the commercial product intended and not industrial accidents.

Uniform Regulations Mean Savings

It is a generally recognized fact that one-fourth of all industrial fatal and non-fatal accidents are due to mechanical causes. From a nation-wide point of view this means that 6000 fatal and 750,000 non-fatal accidents are traceable to this cause. If all the regulatory bodies had uniform regulations which were uniformly applied and used by manufacturers in guarding their products, allowing time for the replacement of old machines with new, it would not seem to be too optimistic a statement to say that at least one-sixth of the accidents due to mechanical causes, or 1000 fatal and 125,000 non-fatal accidents per year, would be prevented.

This would be a tremendous saving in human life and suffering as well as a saving of approximately $35,000,000 in wages and $8,000,000 per year in compensation and doctors' bills, to say nothing of the savings from the decrease in cost of labor turnover, material spoilage, property damage, and the increase in production.

It should not be understood from the previous statements that the machine tool builders or

any other group of manufacturers desire that such a state of affairs should continue to exist. Word has come from the machine tool industry that it is ready and willing to do all that it can toward the equipping of machines with adequate guards at the point of manufacture as soon as there is brought about some degree of harmony in existing regulations. Such a statement is a definite challenge to the entire accident prevention movement and to all those associated in any way with the movement.

Many States Adopt Codes

There are many indications that the challenge is being accepted and met. The action taken by the Industrial Commission of Maryland in adopting, verbatim, twenty national safety standards; that taken by Nebraska in basing its recently adopted standards on the national standards; that taken by such states as Pennsylvania, New Jersey, New York, Ohio, California, and several others in basing their regulations on the national standards and adopting many standards, verbatim, are concrete evidences of progress that is being made. The Association of Governmental Labor Officials at their last annual convention approved and endorsed, unanimously, a recommendation made by a special committee that the national standards be used by the states in the preparation of their own safety standards. Many states, including Virginia, West Virginia, Maine, Tennessee, and Idaho, have appointed commissions to consider the necessity and desirability of passing legislation that will permit the adoption of national safety regulations. All of these facts indicate that governmental agencies have become awakened to the situation and are doing their part to bring about the uniformity in development of safety standards that is so urgently needed.

Industry can do much more than indicate a willingness to use the national standards when some degree of uniformity has been reached. It can begin to demand uniformity from the viewpoint of the economic benefits which industry will derive. Through individual establishments it can encourage regulatory bodies in their efforts to adopt standards that are uniform with those of other states. Establishments having plants located in several states can use national standards as the uniform regulations for accident prevention work, whenever they are not in conflict with local regulations. Industry can, to a far greater extent than it is now doing, use existing national standards in connection with the manufacture of its products without fear of running counter to local regulations. Whenever industry feels that any national standard does not meet its needs, it can point out to the national committee which developed the particular regulations in question the facts which will make clear such weaknesses and thereby assist the committee in making the standard more generally acceptable.

It would be possible to demonstrate, at considerable length, various other ways in which insurance interests, governmental agencies, industry in general, and individual industrial establishments can cooperate in eliminating these conditions which now have a strangle hold on the program of eliminating accident hazards. To do so would simply serve to emphasize the necessity that exists for every organization and individual to join with the American Standards Association in bringing about a degree of uniformity that will permit safety standards to be the prominent factor in the accident prevention movement that they rightfully should be.

Standard System of Fits Tentatively Adopted in Denmark

The American Standards Association has received a series of Danish standard sheets specifying a series of fits between cylindrical parts.

The Danish system (which is the same as the Swedish) has been adopted in a tentative manner in consideration of the work now going on under the auspices of the International Standards Association (ISA) in developing a unified system of fits acceptable to all industrial countries (see "International Unification of Standard Fits," ASA BULLETIN, September issue).

The main features of the Danish system are as follows:

The standard reference temperature for gages is 20 degrees Centigrade (68 degrees F).

Both the basic hole system and the basic shaft system are given in the standard. In each system there are specified altogether 27 different classes of fits, subdivided into three "grades." Grade 1 holes and shafts have relatively small tolerances; grade 2 holes have tolerances which are twice as large for a given nominal diameter; and grade 3 holes have tolerances which are three times as large as those for grade 1 holes. In the same way, the tolerances on grade 1, 2, and 3 shafts are in the ratio 3:5:8, respectively. These ratios have been slightly modified by the fact that an aver-

age value has been adopted as a constant balance for a certain range of diameters.

There are five grade 1 fits, eleven grade 2 fits, and eleven grade 3 fits. Each hole and shaft is designated on drawings by a symbol consisting of a letter designating the class of fit, followed by a numeral designating the grade of fit. Thus a fit equivalent to an American standard "free" fit is indicated by the symbol H2-e2.

The range of diameters covered is from 1 to 500 mm, that is, from about 0.04 inch to about 20 inches. The sub-division of the total range of diameters into subranges, for each of which the tolerance on both parts remains constant, is the same as proposed in the system now in course of development under the auspices of the ISA.

Consideration has also been given, in the Danish standard, to the manufacturing limits and the permissible wear of gages. A small tolerance on the new gage is given in the direction opposite to the wear of the gage. That is, a plug gage is given a plus tolerance, while a snap gage is given a minus tolerance. Generally speaking, the "go" gages are allowed to wear past their nominal size to an amount equal to the manufacturing tolerance. Thus, for example, a plus gage for a 1 inch, grade 2 hole, is given a manufacturing plus tolerance of 2 microns (about 0.00008 inch) and is allowed to wear down by this amount below its nominal size before being rejected.

No specifications have been laid down for "not go" gages.

NEMA Publishes Motor and Generator Standards

A new book of motor and generator standards has just been published by the National Electrical Manufacturers Association. This book is a valuable reference work of practical information on the manufacture, test, performance, and application of alternating and direct current motors and generators, frequency converters, and motor-generator sets of small and large power capacities.

The volume contains over 550 rules dealing with rating, performance, manufacturing, application, and commercial considerations. It also includes a large section devoted to the definitions of electrical terms and abbreviations met with in the motor and generator industry.

It contains the information mentioned above as applied to the following apparatus: small and large power motors (both a-c and d-c), elevator motors, crane motors, a-c and d-c engine driven generators, frequency converters, and motors above 60 cycles for industrial purposes, synchronous motor-generator sets of 200 kw and larger, and farm lighting plants.

Much of the material is entirely new, including ratings for large power d-c motors and elevator motors, minimum efficiencies and indicated starting currents for fractional horsepower motors, ratings and specification forms for a-c generators, definitions for squirrel-cage and other motors, and the Department of Commerce simplified practice recommendations on carbon brush sizes.

Four entirely new sections covering crane hoist motors, synchronous motor generator sets of 200 kw and larger, large power synchronous motors, and frequency converters, and motors for industrial purposes at frequencies above 60 cycles have been added.

A large number of tables have also been added covering standard horsepower and speed ratings and standard compressor applications and of the factors governing such application for large direct connected synchronous motors.

An entire section is devoted to the standard method of making connections and marking terminals for the various types of motors and generators covered by the book.

All old material previously issued has been revised, edited, and rearranged.

Many of the rules and definitions have been approved as American Standard by the American Standards Association, the NEMA having acted as sole sponsor or joint sponsor with other organizations. An asterisk placed at the end of the title of a standard indicates that in addition to having been adopted by the NEMA, it has been approved by the ASA.

The book is 8 by $10^1/_2$ inches in size and has 132 pages. It may be obtained from the National Electrical Manufacturers Association, 420 Lexington Avenue, New York, at $1.50 per copy. Sustaining-Members may borrow a copy from ASA Information Service.

A.S.T.M. Publication Available

A publication of the American Society for Testing Materials, comprising a list of standards which have been adopted by the A.S.T.M., and tentative standards which are now in process of development, has been received and is available for loan or purchase through the ASA Information Service. The standards are listed under the following subjects: ferrous metals; non-ferrous metals; cement, lime, gypsum, concrete, and clay products; miscellaneous materials; miscellaneous subjects.

Many Industries Use Quality Standards to Maintain and Improve Markets

The use of standards and specifications is becoming increasingly important in maintaining the market for an industry's products, as indicated in the following quotations. The first is from the June, 1930, issue of the *Journal* of the American Zinc Institute, and is an excerpt from an address made by Dr. Hugh P. Baker, manager of the Trade Association Department of the U. S. Chamber of Commerce, before the Annual Meeting of the Institute. Dr. Baker says:

> "Still another problem that is rather common is declining business resulting from failure to maintain standards and quality. I sat in a short time ago with an industry, a very old industry in this country, and found to my amazement that the business of that industry had fallen off 40 per cent in the last ten years, and, so far as I could determine, the reason for this serious decline in business in this industry was that they were failing to maintain standards and quality, and were, therefore, playing directly into the hands of substitutes or their competitors."

The cast iron industry supplies an example of the use of standards and specifications to improve the general market for the industry's products. Similar efforts by other industries have been cited in the ASA BULLETIN.

O. W. Potter, assistant professor in the College of Engineering and Architecture at the University of Minnesota, writing in the May, 1930, issue of *Iron Age*, gives his opinions as to what the industry must do to hold its place in the market against the inroads of other products:

> "If the foundryman will stick to his field," he says, "study the properties desired and how to control them, and constantly strive to improve these properties, and furnish a uniform and reliable cast iron, he will automatically enlarge his market, improve the reputation of cast iron, and more firmly entrench it against the inroads of substitutes.
>
> "The designer and the buyer, on the other hand, have frequently been unfair to cast iron. Many times have we seen cast iron, malleable steel, and even non-ferrous castings made from the same pattern, showing clearly that the designer didn't take into consideration the different properties of these various materials. Up until a few years ago mechanical engineers were not required to study metallurgy and, therefore, did not know very much about the properties of the engineering materials. What is needed is more complete cooperation on the part of the casting user, engineer, and the foundryman in determining the true properties of cast iron and in setting up proper specifications for the various castings.
>
> "The foundrymen have already realized this need by organizing the Gray Iron Institute, through which they are going to study the properties of cast iron, classify castings, set up specifications, and work for standardization and improvement of properties and practice. Through this organization they will put cast iron into uses where it rightfully belongs and take it out of places where it does not belong, and thus assure the casting user of a better and more reliable product. This move on the part of the foundrymen is already showing results and the future holds out great promise."

The establishment of a shellac standardization bureau by the United States Importers' Association is another example of the trend toward the use of standards and specifications as a means of avoiding degradation of quality, according to the *New York Oil, Paint and Drug Reporter* for May 19, 1930. The standardization bureau was formed to help protect importers and consumers of shellac from the ill effects of the steady decline in quality of the product shipped from foreign parts to the United States.

> "Failure of shellac exporters to maintain a standard quality conforming to the official standards has resulted from time to time in the shipment of shellac far below official samples. It has been a problem steadily gaining in importance and importers have been forced to seek ways and means of protecting themselves and their customers."

The plan for the standardization bureau includes the examination of shipments of shellac from abroad and the issue of certificates of quality for shipments meeting the specifications. Provision is also made for the settlement of any disputes which may arise in the operation of the plan through existing arbitration machinery of the United States Shellac Importers' Association.

Rationalization and Scientific Management Discussed by Taylor Society

Meaning of rationalization and engineer's part in movement discussed at Taylor Society meeting

At a dinner meeting of the Metropolitan Section of the Taylor Society, held on October 9, 1930, Dr. H. S. Person, managing director of the Society, gave a very interesting talk on the subject "Rationalization and Scientific Management," passing in review the different interpretations which have been given of this term in the course of time. Dr. Person started out by explaining the philosophy of Walter Rathenau, once the head of the German General Electric Company, who was also a manager or director in 86 German and 21 foreign enterprises, organizer of the German War Raw Materials Department, and later Minister of Reconstruction in the post-war Cabinet of Fulfillment. Rathenau's vision of rationalization was a kind of ideal state where all functions of human society would be coordinated and balanced so as to produce the greatest benefit for man.

The speaker explained that although Rathenau's great success as an organizer and manager of corporations caused his writings to make a profound impression in Germany, the stimulus to practical action or a "rationalization movement" did not come until after the war under the great pressure of the need for economic reconstruction. The speaker emphasized that Rathenau's original philosophy applied primarily to an ultimate condition of equilibrium between social forces and not so much to the technique of bringing about greater efficiency in a particular industry. This technique which, Dr. Person said, had come to be called "scientific management," was regarded by the speaker as a tool to be used in arriving at the ultimate goal of the "rationalized society" according to the Rathenau ideal. The gist of Dr. Person's paper is crystallized in the definitions quoted from a brief memorandum by the speaker to those attending the meeting, as follows:

> "*Rationalization*—a *doctrine* of industrial economy, involving socially-controlled integration and coördination of industries self-governed in detail management, without any implications of the technique of organization and management of the industries rationalized.
>
> "*Scientific Management*—a *technique* of organization and management of an enterprise, a group of enterprises, and integrated industry, or all industry for the accomplishment of a common purpose with a minimum expenditure of energies, a minimum of disutilities, and a maximum of human welfare.
>
> "In other words, Rationalization should be conceived as connoting one goal of industrial economy; Scientific Management as a means to any chosen goal of industrial economy."

The engineer's part in rationalization was discussed, under Dr. Person's invitation, by Mr. John Gaillard, Mechanical Engineer of the ASA. Mr. Gaillard stated that the engineer's part was important, in the first place, because he was in charge of establishing those satisfactory physical living conditions—such as food, clothing, shelter, and means of transportation and communication—which form the soil required for the development of a higher culture, that is, of any "better world to live in." Furthermore, the engineer, being expected to produce results, had developed a technique of his own in tackling problems—the "engineering approach," consisting of a three-dimensional compromise, one dimension being the distance between what is known and what is not known of a subject; the second dimension the difference between what is technically practicable and impracticable; and the third dimension being the question of cost. Finally, an industrial organization being in several respects a state in miniature, rationalization in industry, if and when integrated, would lead to rationalization on a larger scale, such as the coordination between entire industrial groups.

In the speaker's opinion the most commonly accepted meaning of the term "rationalization" was, nowadays, the principle of doing everything in "the one best way," whether the problem concerned was in the industrial or in any other field, such as banking or education. In support of this statement, reference was made to the "Handbook on Rationalization" published by the German Council on National Economy (Reichskuratorium fuer Wirtschaftlichkeit,

RKW), which might well be called "Council on Rationalization." The RKW is a semi-official body getting financial support from the German government to allocate funds to German organizations fostering rationalization. Thus, for example, the German national standardizing body (Deutscher Normenausschuss) has been given part of this financial support. In addition to the national standardizing body, other bodies dealing with scientific management applied to different fields of activity, such as branches of industry, agriculture, and technical education, receive subsidies from RKW. The handbook published by the latter body deals principally with engineering methods, as may be realized from the following condensed table of contents giving the major subdivisions:

HANDBOOK ON RATIONALIZATION[1]

I

The Rationalization Movement

1 German agencies promoting rationalization
2 The rationalization movement in other countries, and international efforts toward rationalization
Appendix 1. List of private and official organizations taking part in rationalization work
Appendix 2. Historical review

II

The Means of Rationalization

1 Means of rationalization in unification
- Standardization
- Purchase specifications
- Methods of testing materials and knowledge of materials

2 Means of rationalization in production
- Methods of production
- Planning of work
- Design
- Routing of orders
- Standard tasks and time study
- Work instruction sheets and preprints for machine production
- Part lists
- Performance of work
- Continuous flow production
- Specific production methods
  - Cooling and lubricating in working metals
  - Die casting
  - Welding
  - Painting
  - Punching
- Equipment and accessories required in production
  - Transmission of energy
  - Transportation in factory production
  - Packing technique
  - Applied kinematics
  - Simplified methods of calculation nomography
- German organizations dealing with heat economy

3 Means of rationalization in management and distribution
- Organization and office management
- File systems
- Purchases and stock-keeping
- Accounting, particularly standard bookkeeping practice
- Banking, particularly economy in transfer of funds
- Unification in business statistics
- The principle of budgeting in the industrial concern
- Marketing problems
- Rationalization of the distribution of goods
- Unification in state and municipal departments
- Digest of literature and terminology

4 Means of rationalization in professional training
- Training and education
- Further development of the practicing production engineer
- Selection of the industrial worker

5 Means of rationalization in the manufacturing industries
- Technical rationalization
- Commercial rationalization of the manufacturing industries

6 Means of rationalization in the domestic sciences
- Preliminary remarks
- The domestic science information file in the Reichskuratorium
- Proposals for rationalization of domestic science on the basis of research
- Results

III

Methods, Application, Results

Introduction: Results of coöperative work
1 Investigation of the efficiency of business organizations
2 Practical examples of rationalization
3 Bibliography for Parts I to III
4 Index

[1] Published by the Reichskuratorium fuer Wirtschaftlichkeit, under the editorship of Dr. Fritz Reuter. Second edition (unchanged), Berlin, 1930, "Industrieverlag Spaeth und Linde," 1234 pages. Available in the United States at G. E. Stechert Company, $3.75, delivery four weeks after order.

Cleaning Materials Pamphlet Issued by Standards Bureau

The United States Bureau of Standards has issued a circular on washing, cleaning, and polishing materials. The publication includes, according to the introduction, discussions on:

> "the use of water in laundering, pointing out the effects of impurities in water, and means for their elimination. A brief description of the general composition of soap, soap-manufacturing processes, and the common varieties of soap products is followed by a short discussion of alkaline cleansers and miscellaneous detergent or laundry aids, such as bleaches, scours, bluing, and starch. Brief discussions are also included on dry-cleaning operations, solvents, dry-cleaning soaps, stain removal, finishing, reclamation of solvent, and elimination of static electricity in dry-cleaning plants. Sections are devoted to furniture and automobile polishes, metal polish, floor wax and polish, polishing cloths, dust cloths, sweeping compounds, and wall-paper cleaner. A list of the Government specifications for the products covered, numerous references, and suggested formulas for some items are also given. Recommended specifications are given in the appendixes for two grades of laundry soap."

In a discussion of specifications in the circular it is stated:

> "Large consumers, such as the various branches of the Government service, municipalities, and so forth, have for many years purchased various materials under definite specifications, and examination of which shows a great variety of requirements for the same kind of material.
>
> "Purchasing materials under specifications necessitates sampling and testing, which are costly operations; hence, it is advisable to purchase under specifications only when the amounts delivered are large. When the amounts purchased are small, it is more economical to buy a brand desired than to incur the expense of testing a product offered at a low price.
>
> "It would be of distinct advantage to both manufacturers and consumers if one specification for any particular type of material could be generally used by a large number of consumers. Such a specification should secure a product suitable for the intended use, but, as far as possible, admit material of regular commercial makes. It should allow the greatest freedom, consistent with quality, in the selection of stock so that the manufacturer can take advantage of both varying market conditions and advances in technology and thus prevent, as far as possible, excessive prices due to temporary scarcity in any specific raw material. Methods of sampling and testing should be clearly defined and be made a part of the specification."

Copies of the circular may be purchased from the Superintendent of Documents, Government Printing Office, for ten cents, or may be borrowed from the ASA Information Service.

Wire Ropes for Marine Uses

The American Marine Standards Committee has just issued a standard for "Wire Ropes for Marine Uses" (number 66), which establishes:

> "minimum quality and defines a maximum range of varieties for the rope requirements of the marine industry. . . . Four optional grades of steel ropes are provided for but cast steel is designated as the basic standard grade."

The size of cast steel rope is comparatively larger for a given load than is required in wire rope of other compositions, but for marine work this is considered advantageous because impairment by corrosion is much slower.

Copies of the standard may be obtained for 10 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C., or through the ASA Information Service.

Purchasing and Testing Methods Subjects of New Papers

The following papers, which may interest Sustaining-Members of the American Standards Association, have recently been published:

Testing Method for Determination of Corrosion of Aluminum and Aluminum Alloys (Pruefverfahren zur Feststellung der Korrosion von Aluminium und Aluminiumlegierungen). *Zeit. fuer Metallkunde* (Berlin), vol. 22, no. 8, Aug., 1930.

Standardization of Highway Purchase, W. A. Van Duzer. *Good Roads*, vol. 73, no. 8, Aug., 1930, pp. 286–287 and 292.

Electric Elevator Specifications, J. C. Runyon. *Electric Specifications*, vol. 2, no. 3, Sept., 1930, pp. 47–49.

Specifications for Springs May Follow Research

Sustaining-Members interested in small springs will wish to refer to the article in the August number of the *Bell Laboratories Record* "Springs for Telephone Apparatus," by J. R. Townsend, which includes much information of a character fundamental to selection of materials and preparation of specifications for small springs. They may also consult an article by Mr. Townsend under the title "Telephone-Apparatus Springs, A Review of the Principal Types and the Properties Desired of These Springs," which appears in the *Transactions* of the American Society of Mechanical Engineers, 1929, vol. 51 (1), as a contribution of the special research committee on springs.

Mr. Townsend is chairman-elect of the special research committee on mechanical springs of the American Society of Mechanical Engineers. This committee has been promoting and directing research for the past few years in an effort to verify and increase the present knowledge of design, materials, and action of mechanical springs. It is expected that their studies will ultimately lead to proposals for specifications for springs for various purposes. At the present time, experimental work is being conducted for the committee at Union College on elasticity of spring materials, at Lehigh University and the Westinghouse Electric and Manufacturing Company on stresses in large helical and conical springs, while work has just been completed at the United States Naval Experiment Station on fatigues of spring material.

It is interesting that a mechanical element so old as springs is only now being developed through scientific work to a point where it will soon be possible to prepare specifications suitable for general application. The specifications hitherto available have been used only in limited ways by special trade groups or individual companies (the railroads, for example) and have been subject to a great deal of criticism and difference of opinion because most of the information available was of an empirical rather than of a scientific character. The work which has been carried on since 1924 under the auspices of the American Society of Mechanical Engineers has been fruitful in many ways, and articles have been published by Joseph K. Wood, J. R. Townsend, A. M. Wahl, M. F. Sayre, D. J. McAdam, Jr., and others. In this way it is becoming possible so to order and systematize the knowledge of the subject that controversial questions of the past period of spring design will disappear, and standardization of specifications and design practice will result.

Associations Promote Use of Safety Codes

The sub-committee on Promotion of Safety Codes in Industry of the Safety Code Correlating Committee reports that definite cooperation has been promised by the Manufacturers' Association of Connecticut and by Associated Industries of New York State, Inc., in promoting the use of safety codes by industry.

The Manufacturers' Association of Connecticut, as a first step toward carrying out the proposed program, has delegated a member of its staff to serve as contact man between the American Standards Association and the industries of Connecticut.

Mark A. Daly, secretary of Associated Industries of New York, Inc., has offered the complete cooperation of that association in urging industries of New York to become acquainted with the use of American Standards Association Codes. He is also cooperating in the plans for the holding of a conference of a group of industrial executives of New York State to discuss all phases of American Standards Association work.

J. A. Morford, National Industrial Conference Board, 247 Park Avenue, New York City, is chairman of the sub-committee which is responsible for developing the above program.

Nominating Committee Appointed

A committee to consider nominations for president and vice-president of the American Standards Association was appointed at the Board of Directors' meeting on October 17th. The committee's nominations will be presented at the Board meeting in December. The committee consists of three members: Mr. Bancroft Gherardi, American Telephone and Telegraph Company, New York City, chairman; Mr. C. E. Skinner, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania; and Mr. R. J. Sullivan, the Travelers Insurance Company, Hartford, Connecticut.

Appointment to Standards Council

Mr. Walter S. Paine, manager of the Engineering and Inspection Department, Aetna Life Insurance Company, has been appointed by the Bureau to be its third representative on the ASA Standards Council. The Bureau's request for an additional representative was approved by the ASA Board of Directors at their meeting on October 17th.

Canada's Viewpoint on Standardization and Simplification in Industry

by

B. Stuart McKenzie, *Secretary*
Canadian Engineering Standards Association

Abstracts from an address delivered before the Convention of the Canadian Purchasing Agents Association at Hamilton, Canada, on September 26, 1930

The object of all manufacturers is to sell their product, and business prosperity depends on the activity of the buyer. The buyer, or the purchasing agent, is therefore a most important personage, and one whose friendly cooperation in industrial affairs should be cultivated. It is particularly expedient that close relations be established and maintained between purchasing agents' associations and national standardizing bodies, for the prime object of these latter bodies is to bring the buyer and the seller into friendly contact, and thus enable them to come to an understanding which will be of mutual financial benefit. This results in good quality and fair prices, encourages buying, and is thus a great factor in promoting an active market.

In any discussion of the industrial standardization movement the subject of specification comes at once into the picture. The main work of all standardizing bodies consists in preparing and encouraging the circulation and adoption of industrial specifications which can be relied upon, which adequately cover the situation, and which have been carefully thought out by all the parties concerned, that is, by both manufacturers and users and the necessary technical advisers. Specifications should therefore be practical documents, not scientific treatises; should be brief and to the point; and above all should be characterized by their eminent common sense. There is a feeling of security in the use of such a specification, for, since it has been prepared by the cooperative effort of all interests, it is bound to be more comprehensive and accurate than one prepared by individual effort.

An industrial specification may be defined as

> "the concrete expression of an agreement between manufacturers and users as to design or quality of a manufactured article, which agreement has been reached by friendly conference and is recommended for adoption as being in the best interests of all concerned."

Too much emphasis cannot be laid on the idea of "friendly conference," for in this way only can suspicions be allayed, misunderstandings cleared up, and a reasonably permanent solution of the particular problem obtained.

Practically all standard specifications covering material include provisions for tests which have been devised as the result of long practical experience. It is most important that buyers should become familiar with these tests and to that end purchasing agents, inspectors, and designing engineers are advised to consult together frequently. In most cases purchases are made with cost as the prime consideration, but performance or durability is after all the ruling factor. The first cost of an article may be twice that of a similar article but it may last three times as long, so that the more costly article is in the end the more economical. There is at the present time a marked tendency in the preparation of specifications to use performance as a basis rather than design or chemical composition.

The Canadian Engineering Standards Association is a cooperative industrial body, not a department of the Dominion Government, as many believe, having been incorporated in 1919. It has no authority to enforce its standards on industry, and does not desire any such authority. Any assumption of authority would destroy that cordial feeling which now exists between the organization and its industrial friends, a relation which the Association makes an effort to foster.

Under its cooperative policy the C.E.S.A. is enabled to enlist the services of industrial representatives in the solution of various industrial problems. It is in a position to call friendly conferences at which all parties interested may freely express their views. As the Association is not operated for any profit, and is entirely non-partisan, it is enabled, without prejudice,

to freely circulate and encourage the adoption of the reports or specifications which are published as a result of these conferences.

Industrial standardization is closely allied to another great industrial movement known as simplified practice or waste elimination. It is, therefore, quite consistent that a national standardizing body should include this in its work. Briefly, simplified practice consists in the elimination of unnecessary varieties in any one manufactured article. Manufacturers find that they are making and trying to sell many varieties of some specific article which are subject to infrequent call and, being slow moving, take up valuable storage space. A smaller range would serve the buying public equally well, but the larger range is bought mainly because it is in the catalogue. If the manufacturer can effect an economy by eliminating varieties without prejudicing the interests of his customer, a great saving for both may be the result. The manufacturer can thus manufacture for stock with the assurance that his product will meet the market, and in slack times is enabled to keep his staff busy. The customer, on the other hand, is assured of quicker delivery on his orders, and profits from the lower prices resulting from the reduction in overhead and storage charges which the manufacturer has been able to make.

The C.E.S.A. has made a start in this field and hopes greatly to extend operations. An established list of machine screws was issued in 1929 which reduced the variety in this product from 43 to 21, but which still provides a practical working list which will adequately meet the needs of the designing engineer. Work is now being done on similar lists covering cap and set screws, machine, carriage, and plough bolts, machine bolts and nuts, and so forth. The Association has also sponsored a simplified list for square and round reinforcing bars, reducing the variety from 18 to 11 in sizes from $\frac{1}{4}$ inch to $1\frac{1}{4}$ inches. This list has been approved by both manufacturing and construction interests and is now practically standard in the construction field. In the electrical field the specification for incandescent lamps includes dimensions for standard screw sockets, the varieties of which have been reduced from 179 to 6 by standardization. A specification for control cable for power-houses provides for the identification of 15 conductors by the use of not more than two colors and a single design in the braid. Previously, as many as three different colors were used at one time and each manufacturer had his own range of braid designs.

These brief references show the possibilities which are open for future endeavor in the fields of standardization and simplification, and indicate the important rôle which can be filled by a national standardizing body. The functions of such a body, as exemplified by the work of the Canadian Engineering Standards Association, may be briefly summarized as follows:

Promoting of friendly relations between manufacturers and users.

Assisting manufacturers to effect economy in manufacturing and thus give the user the advantage of lower prices.

Showing the user the value of standard specifications and the wisdom of buying to a smaller range in variety.

Relieving the user of the necessity of preparing his own specifications.

Solving of industrial problems by conferences in which all interests are represented.

Drafting of rules for the protection of life and property.

Promoting uniformity in manufacturing practice and quality of material throughout Canada.

It would be quite impossible within the compass of a brief address to give a detailed account of the work which is being carried on in Canada and in other countries throughout the world by these national standardizing bodies. It is hoped, however, that sufficient information has been given to demonstrate the fact that industrial standardization and simplification can be of financial benefit to those who understand and intelligently apply the principles underlying these two great movements. Canadian industries are, therefore, consulting their best interests by cooperating with their own national standardizing body and supporting it in every way possible.

BESA Aluminum Standards

The British Engineering Standards Association has just issued a group of standards relating to aluminum. These may be borrowed for review, or purchased for sixty cents per copy, from the ASA Information Service. The standards are:

396-1930 Wrought light aluminum alloy tubes for general engineering purposes. This specification covers the alloy generally known as duralumin.

395-1930 Wrought light aluminum alloy sheets and strips. This specification also covers the alloy generally known as duralumin.

385-1930 Pure aluminum tubes for general engineering purposes. This specification covers aluminum tubes up to 6 inches and gives test information.

386-1930 Pure aluminum bars and sections for general engineering purposes (excluding wire bars).

388-1930 Aluminum powder for paints. This specification is one of a series of about 60 specifications for paints, varnishes, and paint ingredients.

A Review of Electrical Engineering Projects under ASA Procedure

The first of a series of reviews of standardization projects under the procedure of the American Standards Association

A review of all electrical projects completed or in process of development under ASA procedure is given below. This is the first of a series of such reviews to be published in the ASA BULLETIN. It is planned to have these reviews eventually cover all ASA projects. The information is corrected to November 1, 1930. The personnels of the sectional committees handling the projects are not included but may be found by reference to the 1930 American Standards Year Book, pages 52 to 61, under the heading "Electrical Engineering" (C).

It is hoped that a clear understanding of the exact status of each project will expedite the further development of many projects which have been delayed by more or less inconsequential matters. It will be appreciated if any errors noticed will be called to the attention of the ASA office so that corrections can be made.

C1-1930—Regulations for Electric Wiring and Apparatus in Relation to Fire Hazard ("National Electrical Code")

Scope—Requirements for the installation of electric wiring and equipment for light, heat, and power, as they affect the fire hazard, and for signaling systems, so far as they may involve such hazard. The Code also includes equipments affecting the life hazard in numerous applications and uses.

This Code, under the sponsorship of the National Fire Protection Association, undergoes periodic revisions. The edition at present in force, known as the 1930 Edition, was approved as an American Standard in July, 1929.

The personnel of the Sectional Committee for the 1931 edition was approved by the Standards Council at its meeting on June 12, 1930, and a sub-committee was appointed to consider the addition of a representative from one additional organization.

One meeting of the sectional committee has been held, at which various questions of policy were discussed and reports of sub-committees presented. It was decided to retain Articles 37 and 60 (radio equipment and signal systems) the elimination of which had been considered.

At a meeting of the Electrical Advisory Committee held May 27, 1930, Mr. A. R. Small, speaking for the sponsor, reported action taken by the Sectional Electrical Committee and approved by the sponsor at its 1930 annual meeting, relative to interim changes of desirable and non-controversial requirements of the Code. A definite formal procedure has been adopted, the final step of which requires a letter ballot of the sectional committee membership. The plan had unanimous endorsement of the attendance at the annual meeting of the sectional committee and at that of the National Fire Protection Association. By means of such interim revision procedure it will be possible to erase conflicts observed in recently published texts and to recognize new applications of ideas in the installation of wiring and apparatus without the delays necessarily involved in the usual biennial publication program. Stress was put on the basic feature of the plan, which was to have it available only to matters ascertained to be both desirable and non-controversial.

C2-1927—National Electrical Safety Code

Scope—Protective grounding of circuits and equipments; installation of machinery, switchboards, etc., in generating stations and substations; installation and maintenance of electrical wiring and utilization apparatus, and of supply and signal lines, both overhead and underground, and the operation of electric lines and equipment—all from the point of view of casualty hazards.

This Code, under the sponsorship of the United States Bureau of Standards, was first approved as an American Standard in 1922. The present edition was given the status of American Standard in 1927. The work of developing this last edition of the Code was done by two sectional committees—the first developed Parts I and III, covering interior work and grounding, and the second developed Parts

II and IV, covering line construction, operating rules, and so forth.

Several organizations having a major interest in this Code are doing extensive fundamental research work relating chiefly to strength of lines and loading, looking forward to the preparation of the next edition of the Code. It is felt by these interests that when the research is completed a new edition of the Code will be possible which will be fundamentally more sound and at the same time more satisfactory to all concerned.

The complete Code is published by the Bureau of Standards and is designated as Handbook No. 3 of the Bureau. In addition to the complete edition the various parts are available as separate pamphlets.

C3-Electrical Fire and Safety Code

A combined Electrical Fire and Safety Code was proposed in the original group of safety codes recommended by the Safety Code Correlating Committee in 1920. Sponsorship was assigned jointly to the National Fire Protection Association and the United States Bureau of Standards on April 3, 1920.

On July 8, 1920, the Electrical Manufacturers Council (one of the predecessor organizations of the National Electrical Manufacturers Association) proposed that the project be dropped. On March 29, 1922, the N.F.P.A. asked to be relieved of sponsorship. On June 15, 1922, a general formal conference was authorized to discuss the whole subject and establish a policy. Two informal conferences were held and on March 17, 1925, a report was rendered which recommended that a formal conference should consider four possible alternatives. This report was officially received by the main committee of the A.E.S.C.

Such a formal conference was never held and the subject still remains on the ASA books, no formal disposition of the matter having been made.

C5-1929—Code for Protection against Lightning

Scope—Protection of buildings (including powder magazines), oil tanks, gas holders, smoke stacks, trees, airships, live stock, and persons against lightning.

This Code, prepared under the joint sponsorship of the American Institute of Electrical Engineers and the United States Bureau of Standards, comprises five parts.

Part I, "Protection of Persons;" Part II, "Protection of Buildings and Miscellaneous Property;" and Part III, "Protection of Structures Containing Inflammable Liquids and Gases," were approved by the ASA in April, 1929—Parts I and II as American Standards, and Part III, as American Tentative Standard. Parts IV and V, "Protection of Electrical Circuits and Equipment against Lightning," were printed by the Bureau of Standards as a preliminary report of the sectional committee, under the title of "Protection of Electrical Circuits and Equipment against Lightning," in September, 1929, for the purpose of eliciting criticism and suggestions. It is expected that the question of approval of these parts will be taken up after the lapse of a reasonable trial period.

C6-1925—Terminal Markings for Electrical Apparatus

Scope—A system of connections and of markings for terminals for electrical equipment, including generators, motors, converters, transformers, and power control apparatus, together with the auxiliaries ordinarily furnished with such apparatus.

This standard was approved as an American Standard on April 28, 1925, and is under the sponsorship of the National Electrical Manufacturers Association. This work was formerly under the sponsorship of the Electric Power Club, one of the predecessor organizations of the NEMA. At the present time work is being done on a revision of the standard. The question of terminal markings is of considerable international importance, and the sectional committee participates in international work through the medium of the International Electrotechnical Committee. A meeting of the committee was held on June 6, 1930, at which there was a thorough discussion of the questions involved in the proposed revision.

C8—Insulated Wires and Cables (Other than Telephone and Telegraph)

This project was initiated in 1921, under the joint sponsorship of the following ten organizations:

American Electric Railway Association.
American Institute of Electrical Engineers.
American Railway Engineering Association.
American Society for Testing Materials.
Association of Edison Illuminating Companies.
Association of Railway Electrical Engineers.
National Board of Fire Underwriters.
National Electric Light Association.
National Electrical Manufacturers Association.
National Fire Protection Association.

The sectional committee's work has resulted in the approval of the following specifications by the ASA:

C8b1-1928 Tinned Soft or Annealed Copper Wire for Rubber Insulation—approved American Standard June 12, 1928.
C8b2-1928 Soft or Annealed Copper Wire—approved American Standard June 12, 1928.
C8d1-1928 30 Per Cent Rubber Insullation—approved American Tentative Standard April 2, 1928.
C8j1-1928 Cotton Covered Round Copper Magnet Wire—approved American Tentative Standard April 2, 1928.
C8j2-1928 Silk Covered Round Copper Magnet Wire—approved American Tentative Standard April 2, 1928.
C8j3-1928 Enameled Round Copper Magnet Wire—approved American Tentative Standard April 2, 1928.

In addition, the following specifications, after a period of circulation for criticism and comment, have been submitted by the sectional committee, for the approval of the sponsors:

C8d2 "Code" Rubber Insulation.
C8k1 Weatherproof (Weather Resisting) Wires and Cables.
C8K2 Heat Resisting Wires and Cables.

After approval has been given by the sponsors, the specifications will be submitted to the ASA for approval as American Standards.

C10-1924—Symbols for Electrical Equipment of Buildings

Scope—The standardization of symbols used by architects, engineers, and electrical contractors for designating the various electric wiring outlets installed for the purpose of attaching appliances for lighting, motor service, calling, and signaling in buildings.

These symbols were approved as American Tentative Standard on March 6, 1924, the sectional committee being under the joint sponsorship of the American Institute of Electrical Engineers, American Institute of Architects, and Association of Electragists, International.

A revision of the symbols is about to be undertaken at the present time in order to bring them up to date. All of the sponsors have agreed as to the desirability of a revision, and the work will be undertaken as soon as a method of cooperation with the sectional committee Z10—covering abbreviations and symbols in general—is formulated. It has been suggested by one of the sponsors that a proper method of coordination would be to have interlocking membership between this committee and the sub-committees of the Z10 committee covering similar symbols.

C11-1927—Hard Drawn Aluminum Conductors, Physical and Electrical Constants for

Scope—Electrical and related properties of hard drawn aluminum conductors.

This standard, prepared under the sponsorship of the American Institute of Electrical Engineers, was approved as an American Standard on May 2, 1927.

The subject of constants of hard drawn aluminum conductors has important international aspects, and this sectional committee participates in international work through the International Electrotechnical Commission. Much of the international discussion has arisen on account of the fact that aluminum meeting the requirements of this standard must be of a higher degree of purity than that ordinarily used in foreign countries, and the committee has worked with the aim of reconciling the viewpoints of the different countries.

C12-1928—Code for Electricity Meters

Scope—Standards of practice for the maintenance and accuracy of watthour meters, demand devices, and auxiliary apparatus. Summary of good practice for the installing of meters and auxiliaries. Definitions of units and technical terms relating to watthour meters.

This Code, under the joint sponsorship of the United States Bureau of Standards, the National Electric Light Association, and the Association of Edison Illuminating Companies, was approved as an American Standard on February 20, 1928. The present is the third edition of the Code, the second edition having been approved by the ASA in 1922.

This Code may be considered the fundamental authority on all matters relating to watthour meters and demand meters. It covers definitions, standards, specifications for the acceptance of types of watthour meters, and auxiliary apparatus for use with such meters, installation methods, test methods, laboratory and service tests for watthour meters, as well as similar information relative to demand meters.

The Code has been used as a basis for proposals made through the United States National Committee, the International Electrotechnical Commission for international standardization of watthour meters.

C13-1926—Specifications for Tubular Steel Poles

Scope—Specifications covering method of manufacture, selection of materials, dimensions and weights and their tolerances, inspection and testing, for tubular steel poles used in electric line construction.

These specifications, under the sponsorship of the American Electric Railway Association, were approved as American Tentative Standard on October 14, 1926.

The importance of this work is easily understood when it is considered that fourteen hundred combinations of tubular steel poles have been shown in a catalogue of a single company, while this specification lists sixteen which are sufficient to meet practically all commercial needs. The specifications contain a simple table of deflections, together with the formula from which they are computed, for use in the selection of poles. The specifications apply to built-up tubular steel poles of three sections.

No revision of these specifications is contemplated at the present time.

C15-1923—600 Volt Direct-current Overhead Trolley Construction

Scope—Design and erection of overhead trolley systems, including the supporting structures and supporting systems, but not the material.

This standard was approved by the ASA as an American Tentative Standard on July 30, 1923, the sponsor being the American Electric Railway Association. In May, 1928, the A.E.R.A. requested, and was later granted, proprietary sponsorship for the project. Work is now going forward under the auspices of the A.E.R.A.

C16—Radio

A request for standardization in the radio field was received from the Bureau of Standards in December, 1922. The usual conference for discussion of the project was held in January, 1923, and upon the recommendations of the conference joint sponsorship was assigned to the American Institute of Electrical Engineers and the Institute of Radio Engineers. On account of differences of opinion on jurisdictional questions and questions of the right of the committee to initiate activity in fields where organizations were already at work or expected to be, little if any progress was made in the technical work assigned to the committee until early in 1928. The personnel of the sectional committee was submitted to the ASA for approval in November, 1928. The work was divided among the following subcommittees: Transmitting and Receiving Sets and Installations; Component Parts and Wiring; Vacuum Tubes; Electro-Acoustic Devices; Power Supply; and Outside Plant.

In July, 1929, a standard covering dimensions and arrangement of terminals on four-pin vacuum tube bases—C16c1—was submitted and approved by ASA as an American Tentative Standard.

In September, 1929, a meeting was held to reorganize the work of the committee, which it was agreed had not been carried forward as rapidly or as evenly as would be desirable. An Executive Committee and officers for the reorganized Sectional Committee were recommended. The work was reallocated on the basis of the following technical committee organization: Radio Transmitters and Parts; Radio Receivers and Parts; Vacuum Tubes; Electro-Acoustic Devices.

The present status of the work of these technical committees is as follows:

Radio Transmitters and Parts.—Several meetings have been held, and the committee is now awaiting material for its consideration from the Institute of Radio Engineers' Committee on the subject.

Radio Receivers and Parts.—The corresponding Technical Committee is functioning actively, and material from it for this technical committee's work should be available shortly.

Vacuum Tubes.—Most of the work of this committee has dealt with standardization of vacuum tube base dimensions and connections. A preliminary report has been published, but a few minor points remain to be settled. When this work is completed the committee plans to continue with the standardization of bulb dimensions and over-all dimensions of tubes.

Electro-Acoustic Devices.—A complete review of the Institute of Radio Engineers' standards has been made. Certain of them are considered suitable for adoption as American Standards, while others had been called to the attention of the I.R.E. Committee on Standardization for revision. When this committee has finished its work on these, it is expected that a complete set of electro-acoustic standards will be available to be referred for adoption and submitted to ASA through the sponsors.

C17—Miscellaneous Pole Line Materials

Scope—Standardization of anchor rods; crossarm, brace, and other bolts; brackets; braces; guy fittings; pole steps; pins; strand; racks; and such other items of manufacture in the same line of industry as are employed substantially by two or more consuming branches of industry. Investigate possibilities of unification of crossarm dimensions for two or more

consuming branches of industry and if this can be secured, standardize wooden crossarms; also pins, brackets and other wooden pole line materials in use by two or more branches of industry.

Initiation of this project was requested by the American Electric Railway Association in 1923. After a study of the field by a specially appointed committee, sponsorship was finally assigned to, and accepted by the Electric Light and Power Group (National Electric Light Association and Association of Edison Illuminating Companies), this acceptance being approved on June 11, 1925. It was originally proposed that the project be a comprehensive one; at the organization conference, however, the project was subdivided, and later it was further subdivided, due chiefly to the existence of the following projects:

Tubular Steel Poles—C13-1926.
600 Volt D-c Overhead Trolley Construction—C15-1923.
Line Insulators for Voltages Not Exceeding 750—C20.
Wood Poles—O5.

To date, this project has not gotten under way.

C18-1930—Specifications for Dry Cells and Batteries

Scope—Standardization of dry cells and dry batteries with respect to types, sizes, assemblies, designating system, terminal arrangements markings, methods of test and possibly required minimum performance, including dry cells and batteries for telephone, ignition, flashlight, radio, and other uses.

These specifications, under the sponsorship of the United States Bureau of Standards, were first approved as an American Standard on February 27, 1928. In November, 1928, work was undertaken on a revision of the specification. The work progressed through several drafts and the revised edition was approved as an American Standard on September 9, 1930. The chief changes in the revised edition have to do with the performance requirements, these having been raised in a number of instances.

C19-1928—Industrial (Electrical) Control Apparatus

Scope—Standards for industrial control apparatus: definitions, service conditions, rating, dielectric strength tests, and temperature and other limitations for industrial control apparatus; for similar control apparatus used for industrial heating; and for rheostats and auto transformers used for starters; but not including marine auxiliary control apparatus, marine propulsion control apparatus, mine locomotive control apparatus, or railway control apparatus.

This standard, under the joint sponsorship of the American Institute of Electrical Engineers and the National Electrical Manufacturers Association, was approved as an American Standard on April 25, 1928. The material contained in the standard is a revision of a previously existing A.I.E.E. standard on the same subject.

Up to the present time no new developments have arisen which would indicate the necessity for a revision.

C20—Line Insulators for Voltages Not Exceeding 750

Scope—The unification of specifications for line insulators for low potentials (up to 750 volts), spools, knobs, cleats, and tubes for outdoor use.

This work, under the joint sponsorship of the American Institute of Electrical Engineers and the National Electrical Manufacturers Association, was initiated in 1925. Little has been accomplished, however, due chiefly to the fact that it was early decided that glass insulators, whose use is restricted to relatively few large companies, did not require standardization, and that it would be impossible to standardize porcelain insulators without conflict with the work of the sectional committee on power line insulators for voltages exceeding 750—C29. About the only other work for the committee, under these conditions, is that of standardizing the threads ordinarily used on porcelain and glass insulators in such a way as to secure interchangeable use of insulator pins. It has recently been decided by the sponsors to request the consolidation of this committee with that of the sectional committee on Power Line Insulators for Voltages Exceeding 750—C29—in order that the question of the standardization of insulator threads, and any other work which may come up relative to low voltage insulators, may be promptly carried through.

C21-1926—Synchronous Converters

Scope—Definitions, classification, rating, and methods of test, heating, momentary load limitations, communication limitations, efficiency dielectric strength, insulation resistance, voltage regulation, direction of rotation, and phase sequence for synchronous converters, field control converters, synchronous booster converters and cascade converters. (For synchronous frequency converters and other synchronous machines, see project C24.)

This standard was submitted by the sponsor, the American Institute of Electrical Engineers, as an existing standard. It was approved as an American Standard on August 8, 1926.

Under date of March 24, 1930, the A.I.E.E.

formally requested that this subject be added to the scope of the work on Rotating Electrical Machinery—C50—for which they are joint sponsors with the NEMA. The matter was referred to the NEMA for their approval of such action on March 29, 1930, and is still awaiting their decision.

C22-1925—Instrument Transformers

Scope—Definitions, rating, and methods of test for transformers for use with measuring or control devices, including short-circuit and open-circuit limitations, dielectric tests, polarity, and terminal markings.

This standard was submitted as an existing standard by the American Institute of Electrical Engineers, on May 22, 1925, and was approved as an American Standard on December 15, 1925, sponsorship being granted to the A.I.E.E. This approval was given with the understanding that a revision would be undertaken under the Sectional Committee Method should any conflicts with other standards arise. To date, however, no need for such a revision has become evident.

C28—Electric Motor Frame Dimensions

Scope—Uniform mounting dimensions for general purpose motors.

This project was initiated in June, 1924, at the request of the National Machine Tool Builders Association. On June 16, 1927, the American Society of Mechanical Engineers and the National Electrical Manufacturers Association were appointed joint sponsors. After having gone through a series of changes in scope (the final scope being as given above), as well as changes in personnel, on February 8, 1930, the proposed standard was formally submitted by the sponsors for approval as an American Standard. Under date of May 22, 1930, a letter was received from the NEMA withdrawing their approval, as one of the sponsors, stating that they wished to submit a series of suggestions for a different method of handling the project.

The personnel of the sectional committee was approved by the Standards Council at its meeting on June 12, 1930, upon recommendation of the Electrical Advisory Committee.

The sectional committee is awaiting the suggestions from the NEMA.

C29—Power Line Insulators for Voltages Exceeding 750

Scope—The unification of specifications including rating, dimensions for interchangeability and tests.

This project, under the joint sponsorship of the American Institute of Electrical Engineers and the National Electrical Manufacturers Association, was initiated in 1925.

Under date of July 29, 1930, the result of the sectional committee's work, entitled "Standard Insulator Tests and Ratings" (C29a), was submitted by the sponsors to the ASA for approval as an American Standard. On September 19, 1930, the standards were approved as American Standard.

All of the material contained in this specification is based upon, but is a complete revision of, the former A.I.E.E. standard on the same subject.

The sponsors have recently requested that the work remaining before the sectional committee on Line Insulators for Voltages Not Exceeding 750 (C20) be added to the scope of this committee's work. This matter will be brought to the attention of the Electrical Advisory Committee in the near future.

C31—Electric Arc Welding Apparatus

C32—Resistance Welding Apparatus

These projects were undertaken in February, 1927, upon request of the American Institute of Electrical Engineers. In March, 1928, joint sponsorship, under the sectional committee method, was assigned to the A.I.E.E. and the NEMA.

It has been agreed by the sponsors that one sectional committee would be able to develop both of these standards. The sectional committee personnel is now complete and, it is understood, will shortly be submitted to the ASA for approval. The organization meeting of the sectional committee is to be held in the near future and the work on the subject of standards for electric welding apparatus thus actively undertaken. The existing A.I.E.E. standards on the subject will serve as a basis for the work.

C33—Electrical Devices and Materials with Relation to Fire and Casualty Hazards

Scope—Specifications and standards for performance and inspection covering (1) fire and/or (2) casualty hazards of devices and materials employed in installations of electric wiring to which the National Electrical Code and related parts of the National Electrical Safety Code apply; but not for devices or machinery used wholly or chiefly in power generation, in substation, on transmission lines and the like, or in railway signaling, telegraph and telephone, or other electrical fields, except as the fire and casualty hazard in the premises served is concerned.

Under date of January 27, 1928, the Underwriters' Laboratories requested that it be designated proprietary sponsor for a project, under the above title, dealing with all devices and materials which would come within its scope. Proprietary sponsorship was formally granted the Underwriters' Laboratories on March 8, 1928. The method of procedure employed by the sponsor is to have the standards developed by the "industry committees" of the Underwriters' Laboratories, which consist of representatives of the Underwriters' Laboratories and of manufacturing interests. Later, endorsements are obtained from all organizations having a substantial interest in the particular project involved.

One standard, Outlet Boxes (C33a), has resulted, and was approved as an American Standard on August 6, 1929. Two other standards, covering flexible cord and panelboards, are now being circulated with a view to obtaining the consensus of opinion of industry, prior to their submission for approval by the ASA. Completion of the work of obtaining a consensus preparatory to the submission of these two standards for ASA approval has been delayed by the raising of the question of their representation at an earlier stage of the work by the Electric Light and Power Group, in order that their point of view may be brought to bear more intimately during the formative stage of the work.

C34—Mercury Arc Rectifiers

Scope—Definition, service conditions, load limitations, power factor, heating, short circuit limitations, dielectric tests, insulation resistance, voltage regulation, efficiency, and rating, but not specifications for performance and inspection covering fire and casualty hazards.

The American Institute of Electrical Engineers was granted sole sponsorship for this project in November, 1927, in accordance with their request made in July, 1927.

In December, 1929, the personnel of the sectional committee was approved by the Standards Council.

In February, 1930, a preliminary draft of standards for metal-tank mercury-arc rectifiers was considered in detail. Since that time numerous meetings of the sectional committee have been held and the draft has been revised several times. The work of the committee is now reaching final form and it is expected that a letter ballot of the sectional committee will soon be taken.

C35-1928—Railway Motors

Scope—Definitions, classification, rating, and methods of test for alternating- and direct-current motors used in the propulsion of railway cars and locomotives.

This work was initiated upon request of the American Institute of Electrical Engineers in March, 1928. The A.I.E.E. was designated sponsor, and the standard was approved as an American Standard in October, 1928.

An internal committee of the sponsor is now at work preparing material relative to a revision of the standard, and when this is put into final form a sectional committee will be organized to consider this material in connection with the revision of the standard.

C36-1928—Railway Control and Mine Locomotive Control Apparatus

In March, 1928, the American Institute of Electrical Engineers submitted its existing standard on this subject for approval as an American Standard. The standard was approved as an American Standard on October 19, 1928. The work will be divided into two parts for revision, first, Electric Railway Control Apparatus (C48) and, second, Electric Mine Locomotive Control Apparatus (C49).

See projects C48 and C49.

C37—Oil Circuit Breakers

C38—Disconnecting and Horn Gap Switches

Under date of March 30, 1928, the American Institute of Electrical Engineers submitted its existing standards covering these two subjects of the ASA for approval as American Standards. After discussion by the Electrical Advisory Committee it was decided that the A.I.E.E. and the NEMA be appointed joint sponsors to prepare revisions. It has been decided by the sponsors that both projects could be handled by a single sectional committee since they are so closely related. No sectional committee has been organized to date, since representations have been made by the NEMA and the NELA that an investigation in connection with oil circuit breakers is going forward and will probably develop new data which will have considerable bearing on a revision of the standard. It is expected that as soon as this investigation is satisfactorily completed, the sectional committee will be organized and the revision actively undertaken.

C39—Electrical Measuring Instruments

Scope—Definitions, classification, rating, methods of test, and construction details for direct-current and alternating-current ammeters, voltmeters, watt-

meters, reactive volt-ampere meters, frequency meters, power-factor, reactive-factor, phase-angle meters and synchroscopes, but not including curve drawing, contacting, low precision, or special instruments.

This project came before the ASA in March, 1928, through the submission by the American Institute of Electrical Engineers of its existing standard for electrical measuring instruments.

During a discussion of the matter in the Electrical Advisory Committee, representatives of the NEMA pointed out that before approval of this material as American Standard they would wish to have it correlated with the standards of the NEMA on the same subject; consequently, the A.I.E.E. and the NEMA were designated joint sponsors for the project. To date, a sectional committee has not been organized by the sponsors.

C40-1928—Storage Batteries

Scope—Definitions, classification, rating, and methods of test for storage batteries of the lead-acid and nickel-iron alkaline types, for stationary and for portable use.

This standard came before the ASA by the A.I.E.E's submission of its standards on the subject for approval as American Standard, with the request that the Institute be granted proprietary sponsorship for the subject of storage batteries. After consideration, the A.I.E.E. was granted proprietary sponsorship in October, 1928, and the standard approved as an American Standard on October 19, 1928.

To date no necessity for a revision of this standard has been indicated.

C42—Definitions of Electrical Terms

Scope—Definitions of technical terms used in electrical engineering, including correlation of definitions and terms in existing standards.

This work was initiated in 1928, upon request of the American Institute of Electrical Engineers, who were granted sponsorship in October, 1928.

The organization meeting of the sectional committee was held in December, 1929. Seventeen sub-committees have been appointed as follows:

1. General (Fundamental and Derived Terms).
2A. Rotating Machinery.
2B. Transformers, including Induction Regulators and Reactors.
3A. Switching Equipment.
3B. Control Equipment.
4. Instruments, Measurements, and Testing.
5. Generation, Transmission, and Distribution.
6. Transportation.
7. Miscellaneous Electromechanical Applications.
8. Welding.
9. Illumination.
10. Electrochemistry and Electrometallurgy.
11. Wire Communication.
12. Radio Communication.
13. Radiology.
14. Electrobiology.
15. Miscellaneous.

The chairmen of these sub-committees form an executive committee which meets monthly except during the summer months. Several preliminary reports have been issued by the sub-committees, and sub-committees 1 (General) and 6 (Control Equipment) have presented final reports covering in each case definite portions of their allotted work.

This sectional committee's work as a whole is progressing rapidly, and when it is completed there will be available to American industry a very complete glossary of electrical terms, something which heretofore has not been available.

C43—Overhead Trolley Line Material (Proposed Project)

Scope—Definitions, classifications of types and applications, materials, construction, performance, and test.

In August, 1928, the National Electrical Manufacturers Association formally requested that a sectional committee be formed to prepare an American Standard on this subject, signifying its willingness to act as sponsor. This request was referred to the Electrical Advisory Committee. In June, 1929, the Scopes Sub-Committee of the Electrical Advisory Committee reported that progress was being made on this subject through informal cooperative interchanges between the American Electric Railway Association, the National Electrical Manufacturers Association, and the American Society for Testing Materials. It is expected that the A.E.R.A. will report definitely in the near future and that arrangements will be made that the subject be treated as an ASA project.

C44—Rolled Threads for Screw Shells of Electric Sockets and Lamp Bases

This project was undertaken upon request of the American Society of Mechanical Engineers, a recommendation to this effect being made by a special committee. Sponsorship was assignde jointly to the American Society of Mechanical

Engineers and the National Electrical Manufacturers Association. The organization meeting of the sectional committee was held on June 6, 1929, and a sub-committee was appointed to work out a proposed standard. This was drafted on the basis of three previous recommendations (not worked out under the auspices of the ASA) as follows:

Report No. 1474 of the Transactions of The American Society of Mechanical Engineers, 1915.

Report of the Sub-Committee of the Standards Committee of the American Institute of Electrical Engineers, 1922.

Report of National Screw Thread Commission published by U. S. Department of Commerce, 1928.

The draft was published in April, 1930, for criticism and comment. It was also circulated to all of the foreign national standardizing bodies.

C48—Electric Railway Control Apparatus

Scope—Definitions, classification, rating, and methods of test for railway control apparatus for electric railway applications, including trackless trolleys.

This project was initiated by the submission by the A.I.E.E of its existing standard on Railway Control and Mine Locomotive Control Apparatus, for approval as an American Standard. After consideration by the Electrical Advisory Committee, the project was divided into two parts: Electric Railway Control Apparatus, and Electric Mine Locomotive Control Apparatus, the A.I.E.E. being granted proprietary sponsorship for the former. In July, 1929, formal notification was received from the A.I.E.E. that a revision of the standard for Electric Railway Control Apparatus was being undertaken. To date no further report has been received from the sponsor.

C49—Electric Mine Locomotive Control Apparatus

Scope—Definitions, classification, rating, and methods of test for electric mine locomotive control apparatus.

This project was originally a part of C36-1928—Railway Control and Mine Locomotive Control Apparatus, above. The sponsors for this part of the project are the American Institute of Electrical Engineers, the American Mining Congress, and the National Electrical Manufacturers Association. To date no sectional committee has been organized. This is due largely to the fact that the Mining Standardization Correlating Committee had raised the question of the relationship of this project to that on Specifications for Locomotives for Coal Mines—M23. In February, 1930, the Mining Standardization Correlating Committee recommended the consolidation of these two projects. This recommendation was concurred in by the Electrical Advisory Committee, which rendered a report to the Standards Council at its meeting on September 11th. The Standards Council ordered that the consolidation be made. It is now expected that work on the larger project, which will be entitled "Specifications for Trolley, Storage Battery, and Combination Type Locomotives for Coal Mines (M25)," will soon be gotten under way.

C50—Rotating Electrical Machinery

Scope—Definitions, rating, and methods of test for (a) direct-current generators and for direct-current motors larger than fractional horsepower; (b) alternators, synchronous motors, synchronous condensers and phase advancers, synchronous frequency converters and synchronous rotary phase-converters; (c) induction motors and induction machines in general; (d) fractional horsepower motors, direct and alternating current.

This project is a consolidation of four separate projects as follows:

D-c Rotating Machines—C23

Alternators, Synchronous Motors, and Synchronous Machines in General—C24

Induction Motors and Induction Machines in General—C25

Fractional Horsepower Motors—C26

These were initiated in 1926 upon request of the American Institute of Electrical Engineers. The A.I.E.E. and the NEMA were granted joint sponsorship for each of the four projects in March, 1928. Subsequent to the decision as to sponsorship, very little, if any, progress was made on the work of the four committees which was to consist of a revision of the existing standards of the A.I.E.E. This condition continued to exist, and in November, 1929, action was taken by the sponsors to have the four sectional committees consolidated into one, covering rotating electrical machinery.

The consolidated sectional committee held its first meeting in February, 1930, and set up a plan of organization with the following subject sub-committees:

D-c Machines
Synchronous Machines
Induction Machines
Fractional Horsepower Motors

Four other sub-committees were set up and

may be called functional committees, their duties being as follows:

1. Efficiency, Power Factor, and Losses
2. Rating, Temperature, Commutation, Overspeed, Mechanical Limitations, Momentary Overload, and Short Circuit Requirements
3. Definitions
4. Dielectric Tests, Insulation Resistance, and Wave Shape

The committees' method of procedure will be to have the subject sub-committees submit to the proper functional committee all appropriate standards material for its type of machinery. The latter will correlate all of the material in its field, and report back to the various subject sub-committees. In this way it is expected to produce standards for rotating electrical machinery which will be uniform in all respects. At the Standards Council meeting of June 12, 1930, the personnel of the sectional committee on Rotating Electrical Machinery was approved.

The committee is now functioning actively and has formulated instructions to the delegates on rotating electrical machinery for the 1930 meeting of the International Electrotechnical Commission. It has also issued a proposed revision of the rules covering efficiency for the four subject committees.

Fire Fighting Equipment Code Approved

The ASA Standards Council has just approved as American Recommended Practice a code for Fire Fighting Equipment in Metal Mines (M17-1930).

The code provides for measures to be taken for the prevention of fires, for fire fighting equipment, fire fighting personnel, and for warnings of fire.

Detailed requirements are included under the heading "Fire fighting equipment" for both surface water supply and hose equipment, and underground water and water supply equipment. American Standard hose (L3-1929—Cotton Rubber-Lined Fire Hose) and screw threads (B26-1925—Screw Threads for Fire Hose Couplings) are specified.

Under the section entitled "Fire fighting equipment" the code also covers the use of fire extinguishers, sprinkling systems, and oxygen breathing apparatus, and provides for the frequent testing of this equipment. It also makes provision for at least one competent man in each mine especially trained in the use of the oxygen breathing equipment as leader, and recommends that at least five per cent of the underground personnel be trained in the use of the breathing apparatus.

Detailed provisions are given for the use of ventilation equipment and proper ventilation, and for the transportation and use of explosives.

Fire-resistant housing for electrical equipment, testing of circuit breakers at regular intervals to insure cutting off of power in case of a short circuit, the establishment of fire breaks or fire-resistant areas, and fire-resistant shafts or compartments carrying power lines are included in the requirements.

A series of bells, flashing of lights, and the introduction of a stench fluid into the ventilation air line are included in the provisions for fire signals.

A fire fighting crew is provided for and requirements are made for marking roads to outlets, for equipping mines with telephones, and for maps (to be brought up-to-date every six months) indicating air currents.

Mr. William Conibear of the American Mining Congress is chairman of the technical committee in charge of the code. The American Mining Congress and the National Fire Protection Association are sponsors for the work. Among the organizations which were represented on the sectional committee are the following: The National Fire Protection Association, the United States Bureau of Mines, the American Institute of Mining and Metallurgical Engineers, the National Board of Fire Underwriters, the National Safety Council, the American Association for Labor Legislation, the National Electrical Manufacturers Association, the Railway Fire Protection Association, the Fire Equipment Manufacturers Institute, the Rubber Association of America, the Underwriters' Laboratories, and the Mine Safety Appliances Company.

Committee of Board Members to Study Certification

A resolution, adopted by the ASA Board of Directors on October 17th, modified the former action of the Board concerning the appointment of a committee to study the question of certification and labeling. The resolution is as follows:

> "Resolved, that the former action of the Board authorizing the appointment of a committee to study the question of certification and labeling be modified by providing for a preliminary study of the subject by a committee whose personnel shall be limited to members of the Board."

ASA Approves Safety Code for Mechanical Refrigeration

A national safety code for mechanical refrigerators of all types, both domestic and commercial, has just been approved by the American Standards Association. Refrigerating apparatus used in the manufacture and processing of materials such as in ice-making plants, cold storage warehouses, ice cream and dairy plants, packing houses, and chemical plants, and also the cooling systems of theaters and other buildings are covered in the provisions of the code, which was prepared by a sectional committee working under the direction of the American Society of Refrigerating Engineers. Commercial plants of the type used in meat markets, florist shops, and restaurants are also covered.

One of the most important provisions of the code, which permits the installation of multiple systems in apartment houses with adequate safeguards to eliminate possible hazards, ends a long-standing controversy on this question. This will probably mean that regulations prohibiting the installation of multiple systems such as exist in New York City and other municipalities will not become an important factor in the refrigeration industry.

Twenty-eight national organizations were represented on the technical committee which has been working on the subject since 1920. These, in addition to the sponsor, are:

United States Bureau of Standards
United States Department of Labor
International Association of Industrial Accident Boards and Commissions
American Institute of Refrigeration
American Chemical Society
American Gas Association
American Institute of Electrical Engineers
American Society of Civil Engineers
American Society of Heating and Ventilating Engineers
American Society of Mechanical Engineers
American Warehousemen's Association
Association of Governmental Officials in Industry
Compressed Gas Manufacturers' Association
Eastern Ice Association
International Acetylene Association
Bureau of Safe Transportation of Explosives
National Association of Ice Industries
National Association of Practical Refrigerating Engineers
National Bureau of Casualty and Surety Underwriters
National Electrical Manufacturers Association
National Electric Light Association
National Fire Protection Association
National Safety Council
New York Board of Fire Underwriters
New York City Bureau of Fire Prevention
Refrigerating Machinery Manufacturers Association
Underwriters' Laboratories

The code applies to both direct methods of refrigeration, in which the refrigerant is circulated through the system, and to the indirect, in which brine or water cooled by the refrigerant is circulated through the system.

Refrigerating systems are classed also in accordance with the amount of refrigerant used, as follows:

Class A	1001 pounds or more of refrigerant
Class B	101 to 1000 pounds, inclusive
Class C	21 to 100 pounds, inclusive
Class D	7 to 20 pounds, inclusive
Class E	6 pounds or less

The code provides that

"Industrial systems using the direct method of refrigeration may be located without restriction in separate buildings or separate sections of buildings provided:

"(*a*) The pressure imposing element, condenser, receiver, and shell type apparatus of Class A systems are placed in a machinery room.

"(*b*) That if a flammable refrigerant is used, the entire building for a Class A system and the machinery room for a Class B system is made of non-combustible material.

"(*c*) Machinery rooms of Class A systems using an irritant or flammable refrigerant have two exits.

"(*d*) The number of workmen employed above the first story does not exceed one for each two hundred (200) square feet of floor area of the stories above the first."

Regulations for Commercial Systems

"Commercial systems using the direct

method for refrigeration are limited in locations as follows:

"(*a*) Any system may be installed in the basement, first story, top story, or on the roof.

"(*b*) If a non-irritant and non-flammable refrigerant is used, systems installed between the first and top story may contain one thousand (1000) pounds or less of refrigerant.

"(*c*) If an irritant or flammable refrigerant is used and the building contains a sleeping room, systems installed between the first and top story may contain one hundred (100) pounds or less of refrigerant. If there is no sleeping room, such systems may contain two hundred (200) pounds or less of refrigerant.

"(*d*) If an irritant or flammable refrigerant is used, the entire system must be confined to the space occupied by a single tenant, if the building containing such system is over three (3) stories in height or if it contains a sleeping room."

Safety Devices Provided for All Types of Apparatus

Several sections of the code are devoted to safety devices which must be provided in all types of refrigerating apparatus. The code provides that in apartment house systems

> "any refrigerant, the vapors of which are harmful to health and which are not readily apparent to a human sense shall have added thereto a substance to make its vapors readily detectable."

While Class B, C, and D systems are permitted in apartment houses, stringent requirements are included for installation, connections, and tests.

Copies of the code may be purchased from the American Standards Association, 29 West 39th Street, New York City, or from the American Society of Refrigerating Engineers, 37 West 39th Street, New York City, at 30 cents per copy.

New Committee Representative

The appointment of H. S. Vassar, Public Service Electric and Gas Company, Newark, New Jersey, as an additional representative of the Electric Light and Power Group on the ASA sectional committee on standardization of domestic refrigerators (B38) has just been announced by the secretary of the Group.

Standard for Analysis of Coal and Coke Approved

The American Standards Association has approved the American Standard methods of laboratory sampling and analysis of coal and coke submitted by the American Society for Testing Materials, the proprietary sponsor for this project.

These methods were originally prepared by joint committees of the American Society for Testing Materials, American Chemical Society, and the American Foundrymen's Association. They were adopted by the American Society for Testing Materials in 1916 and 1918, and were revised in 1921, 1924, 1927, 1929, and 1930 by the committee on coal and coke of the American Society for Testing Materials.

The recent revisions of the methods consist of minor changes in some of the methods of test and do not radically change any of the procedures. These changes are the result of investigations of the methods of analysis with a view of increasing their accuracy. Many of the determinations made in analyzing coal and coke are empirical in nature and require close standardization to secure good agreement between different laboratories.

The methods are generally recognized and used as standard by most of the large consumers of coal in the United States. These methods are extensively used in purchasing coal under specifications for power production. They are also generally used for evaluating coals for gas and coke making properties and by large coal producers who process their coal before marketing to improve its quality. The methods of coke analysis are principally used for evaluating coke for metallurgical purposes. The acceptance of the methods by the American Standards Association broadens their use in this country.

National Electrical Code Recommended

A number of trade practice rules were approved at the convention of the Association of Electragists as being suitable for adoption by the trade practice conference of the electrical contracting industry, under the auspices of the Federal Trade Commission. One of the rules approved by the convention reads as follows:

> "In territories where no governmental laws, rules or regulations as to electrical installations prevail, the regulations as laid down in the National Electrical Code, as approved by the American Standards Association, shall be used."

Dimensions of Woodruff Keys Submitted for Approval

The sectional committee on standardization of shafting (B17) has just submitted to the American Standards Association for formal approval proposed American Standard dimensions of Woodruff Keys. The American Society of Mechanical Engineers is sponsor for the project.

A general review of the proposal indicates that the committee has made no attempt to simplify or coordinate existing sizes regularly produced by any manufacturer, but instead has attacked the problem from the standpoint of the user and has proposed a series of 27 keys of various thicknesses. The radius of curvature of these keys ranges from $1/4$ to $3/4$ of an inch. This series is said to cover approximately 90 per cent of the requirements of the entire consuming industry.

In the early stages of the committee's activity, considerable interest was shown in the matter of "tightness of fit" in the shaft and in the driven member. Several large users preferred a "loose" fit, others preferred a "tight" fit, and still others preferred to see both provided for, selection depending on the particular use or position of the key. With such a variety of industrial demands, it at first appeared impossible to prepare a standard which would be entirely satisfactory. The automotive interests, however, made careful experiments to determine tolerances which would in the majority of cases give what is known to the trade as a "sticking" fit. They found that the limits of the key, the keyslot, and the keyslot cutter must be very carefully controlled to produce the desired results. They also found that for certain shafting or arbor materials, the number of teeth in the keyslot cutter affected the rate of cutting and also, to some extent, the quality of fit of the key in the slot. Upon reviewing the results of these tests, the committee decided to include in the standard both the fine and coarse tooth series for each of the cutter diameters.

A notable advance has been made in the designation of the standard Woodruff Key series. Instead of using an unrelated series of numbers and letters or combinations of the two, a system has been developed in which one series of digits represents the nominal width of the keyslot or cutter, rising by $1/16$ inch increments, and a second series of digits represents the nominal diameter of the keyslot or cutter with $1/4$ inch increments. Two numbers, one from each series in the order shown above, gives the number assigned to the particular standard key.

Copies of the standard will be available after approval by the ASA. Approval is now in process, and will be announced in a future issue of the BULLETIN.

Sub-Committees on Pipe Flanges and Fittings Complete Drafts

Pipe plugs of cast iron, malleable iron, cast steel, and forged steel.—A proposed standard on pipe plugs of cast iron, malleable iron, cast steel, and forged steel, has been prepared by sub-committee number two on Screwed Fittings of sectional committee on Pipe Flanges and Fittings (B16) and is now being widely distributed to industry for criticism and comment.

The proposed standard is based on material originally developed by the Manufacturers' Standardization Society of the Valve and Fittings Industry and adopted by the Society in April, 1929, as a Standard Practice for use in connection with the American Standard for 125 lb and 250 lb Cast Iron Screwed Fittings (ASA B16d-1927) and the American Standard for 150 lb Malleable Iron Screwed Fittings (ASA B16c-1927). It is with these two standards in mind, therefore, that this proposal should be reviewed.

Steel base-fittings for maximum steam working pressure of 250, 400, 600, and 900 lb per sq in.—A draft standard on this subject has been formulated by sub-committee number three on Steel Pipe Flanges and Flanged Fittings and is now being widely distributed to industry for criticism and comment.

This proposal also originated with the Manufacturers' Standardization Society of the Valve and Fittings Industry which adopted it as Standard Practice in October, 1929. As stated in the footnotes below the tabulated dimensions in the draft, this standard is not complete in itself but must be treated as a supplement to, and used in conjunction with, the American Standard for steel pipe flanges and flanged fittings (B16e-1927).

Steel companion flanges.—A draft on this subject, now released by sub-committee number three on Steel Flanges and Flanged Fittings for criticism and comment by industry, is a revision of a former draft generally distributed for the same purpose in February, 1929, which distribution was followed by a questionnaire sent out in December, 1929. The replies to this questionnaire have led to certain revisions which are included in the new draft of the standard.

A limited number of copies of these three draft standards are available for loan through the American Standards Association Information Service.

New Project for Domestic Gas Burning Appliances

The American Gas Association has been appointed sole sponsor for a new project, Approval and Installation Requirements for Domestic Gas Burning Appliances (Z21), by the ASA Standards Council. The scope of the project has been approved as follows:

> "Establishment of minimum or basic requirements for safe operation, satisfactory performance, and substantial and durable construction for domestic gas burning appliances; together with laboratory methods of test for determining compliance therewith."

The sectional committee in charge of the project is under the chairmanship of Mr. R. B. Harper, The Peoples Gas Light and Coke Company, 122 South Michigan Avenue, Chicago, Illinois, and includes in its membership representatives of five gas companies, seven gas appliance manufacturers, the United States Bureau of Standards, the United States Bureau of Mines, the United States Public Health Service, the United States Department of Agriculture, the Bureau of Home Economics, The American Home Economics Association, the Master Plumbers' Association, and the Heating and Piping Contractors National Association. The secretary of the committee is Mr. R. M. Conner, American Gas Association, 1032 East 62nd Street, Cleveland, Ohio.

Radio and Other Symbols Being Correlated

A proposed revision of the Graphical Symbols for Use in Radio Communication (Z10g3) has been prepared and is now in the hands of the Institute of Radio Engineers for their consideration and approval. The revision consists entirely of changes proposed for the purpose of making the radio symbols uniform with those under consideration and those previously adopted by the general sectional committee on Scientific and Engineering Symbols and Abbreviations.

This revision was prompted by questions raised in a letter to the ASA which reads in part as follows:

> "Our people, who are very much interested in the abbreviations and symbols, are opposed to the adoption of the radio symbols as they are, pending correlation by the sectional committee with the work of the other sub-committees so as to eliminate duplications of symbols or terms for the same thing. We are particularly concerned about the radio symbols and those for electric power and wiring because, being a manufacturer of both, and using radio devices in connection with electric control, and vice versa using electric control in connection with radio, particularly the transmitting, we are faced with the necessity of making new prints whenever one of the devices is used which employs a different symbol for radio than it does for electric power work."

After approval by the I.R.E. the revised symbols will be considered by the sectional committee in accordance with the usual ASA procedure.

Motion Picture Society New Sustaining-Member

Standardization problems resulting from the increasing use of wide film makes the affiliation of the Society of Motion Picture Engineers with the American Standards Association as a Sustaining-Member especially noteworthy at the present time.

The Society is sponsor of sectional committee Z6 which developed the two standards Z6a-1928 on dimensions for cutting, splicing, and perforating motion picture film and Z6b-1928 Recommended Practice for Taking and Projection of Motion Pictures.

The Society is also sponsor for sectional committee Z22 which was responsible for the standard Z22-1930 on dimensional standards for motion picture apparatus and recommended practice.

The affiliation of the Society of Motion Picture Engineers with the American Standards Association is expected to give motion picture standardization added impetus.

J. I. Crabtree, Kodak Park, Rochester, New York, is president of the Society, and J. H. Kurlander, 2 Clearfield Avenue, Bloomfield, New Jersey, is secretary.

Standard for Insulator Tests

Copies of the revised American Standard for Insulator Tests (C29-1930) are now available for loan, or purchase at 30 cents per copy, through the ASA Information Service.

The approval of this revision by the American Standards Association was reported in the October, 1930, issue of the ASA BULLETIN.

Institute of Radio Engineers and Light Metals Group New Member-Bodies

The Institute of Radio Engineers has just become affiliated with the American Standards Association as its forty-fifth Member-Body. The Institute has been active in national standardization work for some time.

It is joint sponsor for the sectional committee on Radio (C16), which developed the standard Dimensions Governing Fit of Four-Pin Vacuum Tube Bases, and Arrangements of Terminals, and which is working on the following projects: Transmitting and Receiving Sets and Installations; Component Parts and Wiring; Vacuum Tubes; Dimensions Governing Fit of Four-Pin Vacuum Tube Bases, and Arrangement of Terminals; Electro-Acoustic Devices; Power Supply and Outside Plant.

The Institute has been active in the work of the sectional committee which has just revised the standard Specifications for Dry Cells and Batteries (C18), and is represented on the sectional committee which developed American Standard Table of Preferred Numbers (Z17-1927). It is also represented on the sectional committees on Scientific and Engineering Symbols and Abbreviations (Z10) and Standards for Drawings and Drafting Room Practice (Z14).

Lee DeForest is president of the Institute of Radio Engineers and Harold P. Westman, 33 West 39th Street, New York City, is secretary.

The formation of a Light Metals Group as a Member-Body of the American Standards Association, with the Aluminum Company of America as the first member, was formally approved at the Board of Directors' meeting on October 17th. Dr. Zay Jeffries, 2210 Harvard Avenue, Cleveland, Ohio, has been appointed as representative on the Standards Council.

R. A. Hunt is president of the Aluminum Company of America. The general offices of the company are located at 2400 Oliver Building, Pittsburgh, Pennsylvania.

American Standards Association Annual Meeting December 11

The Annual Meeting of the American Standards Association will be held on Thursday, December 11, 1930, at the Hotel Astor, New York City. Following a meeting of the Board of Directors in the morning, there will be a joint luncheon meeting of the Board and the Standards Council. A meeting of the Standards Council will be held in the afternoon.

Standard for Analysis of White Pigments Approved

The American Standards Association has approved a revised American Standard method of routine analysis of white pigments (K15-1930). The revision, which was proposed by the American Society for Testing Materials, clarifies the method of calculating and expressing the results of the analysis in terms of metallic lead and zinc, lead oxide, zinc oxide, and lead sulphate. This is the only change from the original standard approved by the American Standards Association in 1929.

Copies of the revised standard may be obtained either directly through the ASA Information Service or from the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pennsylvania, for 25 cents.

Correction

In the article entitled "Standard Fits between Cylindrical Parts to Be Studied by ASA Committee," published in the October issue of the ASA BULLETIN, the first part of the first sentence, page 18, paragraph 2, column 2, reads as follows:

> "*Absence* of the basic shaft system in the present standard is based on the consideration that while it may be true that the large majority of users of fits will preferably use the basic hole system, the number of those who could with advantage use the basic shaft system cannot be entirely left out of consideration."

This sentence should read:

> "*Criticism of the absence* of the basic shaft system in the present standard is based on the consideration that while it may be true that the large majority of users of fits will preferably use the basic hole system, the number of those who could with advantage use the basic shaft system cannot be entirely left out of consideration."

The first three words of the above statement were dropped by error in printing the article. Incidentally, it might be pointed out that the absence of the basic shaft system was due to the fact that the technical committee did not deem it necessary to add it at the time the present standard was established. Criticism of the lack of a basic shaft system has since been voiced by several industrial concerns.

STANDARDIZATION WITHIN THE COMPANY

Packard Motor Car Company Purchases Material on Specifications[1]

by

Herbert Chase, *Associate Editor*
Product Engineering

How a large buyer prepares its specifications to assure the purchase of satisfactory materials

Automotive manufacturers are among the world's largest purchasers of steel and iron, non-ferrous metals, hardwood, glass, finishes, rubber, upholstery fabrics, artificial leather, and many other materials. It is natural, therefore, that their purchasing should be well organized and that their material specifications should be prepared with extreme care. Otherwise the present low price of automobiles would be impossible, for the cost of materials represents a very large proportion of the factory cost of the completed vehicle.

Engineers and executives of the Packard Motor Car Company have made a particular effort to see that their material specifications shall assure not alone materials that give satisfactory service in the company's product, but that the materials are such as to facilitate manufacturing operations. Care is used also not to frame the specification in such a way that the purveyor finds the material unnecessarily difficult to produce, for it is realized that such a condition naturally tends to increase the cost and ultimately the price of the material. When particular or even unusual qualities are considered essential, however, the specification is drawn in such a way as to assure these qualities, even though the cost of the material be increased.

In some classes of steel, such as those used for forgings and for deep drawing, a certain size of grain structure is specified. This unusual requirement is intended to insure ready and uniform working with consequent reduction in scrap. In effect, it requires the steel manufacturer to make the steel by a particular process, whereas without this requirement, he might employ some other process which, when the steel is worked, may lead to excessive warping, or to surface conditions that make finishing more difficult.

[1] Reprinted from the June, 1930, issue of *Product Engineering* (McGraw-Hill Publishing Company) by permission of the editors.

An illustration of the care used to assure material that the Packard shops can work to best advantage is the general specification for alloy forging steels, especially those containing $3^1/_2$ or 5 per cent, respectively, of nickel. One of the provisions of this specification requires that the structure "must show a satisfactory grain size and the characteristics of normal steel after being given the Ehn test."

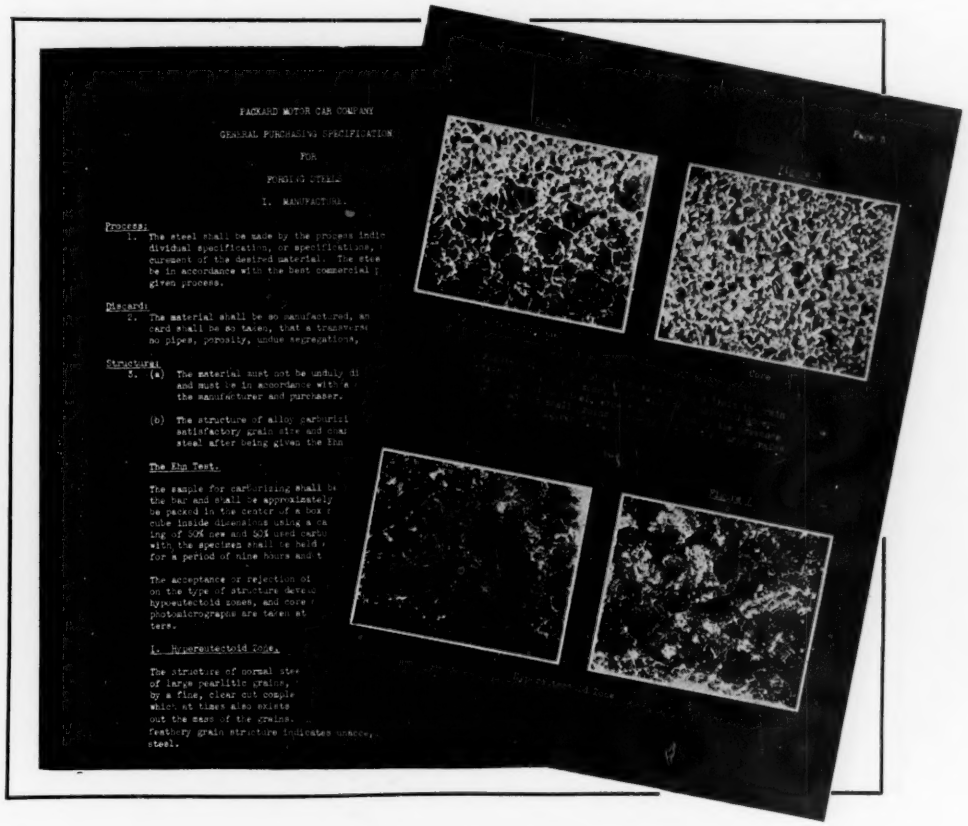
Acceptance or rejection of such steels depends partly upon the grain structure in certain zones, as determined by photomicrographs of 100-diameter magnification. The specification not only describes the grain structure minutely, but contains fifteen photomicrographs showing the structure desired, the maximum and minimum limits in grain size acceptable, the permissible amount of banded or laminated structure, and the character of certain unacceptable structures.

No Increase in Price

Although such a specification may appear unnecessarily complex, it has not presented any serious difficulty to the steel manufacturers, nor resulted in any increase in price. On the other hand, it has resulted in securing steels that react uniformly to the carburizing processes, with minimum warpage. Steels having the relatively large grain sizes specified have been found to carburize more quickly and to machine more easily than steels lacking this characteristic.

Another advance in steel specifications has resulted from five years of carefully coordinated work, as between the Packard metallurgical staff and the press room, where large quantities of sheet steel for deep-drawn body parts and fenders are stamped. This work, recently described in detail in a paper by W. H. Graves, chief metallurgist of the company, before the American Society for Testing Materials, shows that simple laboratory tests are much more accurate and satisfactory than production runs

for determining the suitability of sheet for deep drawing; that the Rockwell hardness tester gives a good indication of the pressure ring setting needed and the spring back obtained, and that the Erichsen tester gives an accurate measure of the depth of draw a sheet will stand and shows also the surface finish secured after drawing. Box-annealed sheets show a considerably rougher surface than do normalized sheets.


PACKARD MOTOR CAR COMPANY

GENERAL PURCHASING SPECIFICATION

FOR

I. MANUFACTURE.

Process:

1. The steel shall be made by the process indicated by individual specifications, or specifications, current of the desired material. The steel shall be in accordance with the best commercial practice given process.

Discard:

2. The material shall be so manufactured, and discard shall be so taken, that a transverse section shall show no pipes, porosity, undue segregations,

Structure:

3. (a) The material must not be unduly coarse and must be in accordance with a sample agreed upon between the manufacturer and purchaser.

(b) The structure of alloy carburizing steels shall show satisfactory grain size and case structure. Low carbon steel after being given the following

The Rhu Test.

The sample for carburizing shall be a round bar and shall be approximately 1 inch in diameter, and shall be packed in the center of a box containing a cubic inside dimensions using a carburizing mixture consisting of 50% new and 50% used carburizing material. The box with the specimen shall be heated to 1700° F. for a period of nine hours and then cooled.

The acceptance or rejection of the material shall depend on the type of structure developed in the hypereutectoid zones, and core structure. Typical photomicrographs are taken at 100 diameters.

1. Hypereutectoid Zone.

The structure of normal steel should consist of large pearlitic grains, surrounded by a fine, clear cut complex which at times also exists throughout the mass of the grains. A coarse feathery grain structure indicates unacceptable steel.

A Typical Specification Prepared by the Packard Motor Car Company to Control the Purchase of Its Materials

As a result of this work the Packard company includes the following items in its sheet steel specifications:

Steel	*Extra-deep-drawing*	*Deep-drawing*
Analysis	S.A.E. 1010	S.A.E. 1010
Erichsen value	10.5 min.	11.0 min.
Rockwell hardness	B-43 to B-53	B-43 to B-53
Grain structure	as per sample or grain size count	

With these specifications in effect, the old controversies as to whether the steel or the die setting is responsible for unsatisfactory stampings has been ended and it is not necessary to run production tests to determine whether shipments of sheets are satisfactory. Simple tests on about 0.5 per cent of the sheets chosen at random is sufficient to make sure that the shipment is or is not satisfactory. If the sheets pass this test there is practically no scrap and any defects are traceable to incorrect and easily correctable die set-up.

S.A.E. specifications, in the preparation of which Packard engineers and metallurgists long have cooperated, are employed extensively by Packard, but often the S.A.E. specification is amplified to secure particular qualities not otherwise assured. In other cases the S.A.E. specification tolerances are widened because manufacture is facilitated thereby without detrimental results in the product. This applies, for example, in the case of No. 62 S.A.E. hard cast bronze specification which provides for a maximum of 0.20 per cent of lead. Packard follows this specification in all respects except that a maximum of 0.60 per cent lead is allowed. This change is not detrimental in the parts for which this alloy is used by Packard, and the increased proportion of lead permits of the use of a certain "virgin-scrap," so called, in the alloy mix, thereby reducing cost.

Since the Packard company operates its own

foundry and makes the various alloys used, it is possible to follow and control certain practices that might prove unsatisfactory under other circumstances.

That old objection raised by steel manufacturers against the specification of both analysis and physical properties is met in Packard practice by specifying a certain analysis and then adding the stipulation that the steel must be *capable* of giving certain physical properties when subjected to appropriate heat-treatment, the nature of which is stated. In a few cases, however, both the analysis and physical properties, as delivered, are specified, but this applies to steels intended for delivery and subsequent working in the heat-treated condition.

Valve-spring wire used by Packard comes from Swedish sources, ready heat-treated. To date no American-made steel wire has been found to give satisfactory service. Breakage, even with the best American wire obtainable, is so frequent, both under test and under service conditions, that its use has not proved feasible. The precise reason for this breakage is not definitely known but it is attributed to unsatisfactory grain structure, resulting from some improperly controlled factor in manufacture, or to minute surface defects at which fractures start.

Specifications for cast iron and malleable iron employed by Packard are conventional and do not cover any alloying elements, since these are not considered necessary.

All rubber used in Packard cars except that in tires, is purchased approximately to A.S.T.M. specifications and is tested for tensile strength, elongation, hardness, and resistance to aging. Electric wires are purchased under S.A.E. specifications.

Lumber used in making body frames is bought cut into pieces approximating in size and shape of the parts for which it is used. Present specifications provide for inspection according to the National Hard Wood Lumber Association rating rules, but more definite specifications, especially as to tolerance on sizes and strength requirements, are needed and are being formulated.

One of the largest items of material used in Packard closed cars is the plate glass for the windshield and windows. All of this is of the shatter-proof type composed of two glass sheets cemented to an intermediate sheet of celluloid. This type is purchased subject to test of occasional samples which are fractured with a hammer to determine the effectiveness of the bond between the glass and the celluloid.

In general, trade names are avoided in preparing Packard specifications for materials. This policy is neither intended nor regarded as a discrimination against branded products, as many such materials meet the company specifications fully. It is considered expedient to maintain at least two sources of supply, and not to confine purchases to branded materials where unbranded makes may be quite satisfactory. At present, however, finishing materials are purchased largely by trade name, although more than one make of finish is used. Undercoats used are of synthetic-resin-base materials, which are somewhat less expensive than pyroxylin-base undercoats and no more difficult to apply or to rub. Finishing coats are of pyroxylin-base materials.

Variations in Quality of Products Discussed

A paper on "Economic Quality Control of Manufactured Product," originally presented before the American Association for the Advancement of Science by W. A. Shewhart of the Bell Telephone Laboratories, has been reprinted by the Laboratories from the *Bell System Technical Journal* of April, 1930.

Since the paper discusses variations in the quality of a product due to causes which can not be determined, it has an important bearing on manufacturing to standards, and should be read by everyone concerned with this subject.

An abstract of the paper states:

> "That we cannot make all pieces of a given kind of product identically alike is accepted as a general truth. It follows that the qualities of pieces of the same kind of product differ among themselves, or, in other words, the quality of product must be expected to vary. The causes of this variability are, in general, unknown.
>
> "The present paper presents a scientific basis for determining when we have gone as far as it is economically feasible to go in eliminating these unknown or chance causes of variability in the quality of a product. When this state has been reached, the product is said to be controlled, because it is then possible to set up limits within which the quality may be expected to remain in the future. By securing control, we attain the five economic advantages discussed in Part III."

The advantages referred to are: reduction in the cost of inspection, reduction in the cost of rejections, attainment of maximum benefits from quantity production, attainment of uniform quality even though inspection test is destructive, reduction in tolerance limits.

Copies of the paper are available and may be borrowed through the ASA Information Service.